INCH-POUND

MIL-PRF-19500/466B(USAF)
19 July 1999
SUPERSEDING
MIL-S-19500/466A(USAF)
30 August 1993

PERFORMANCE SPECIFICATION SHEET

SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, POWER
TYPES 2N5683, 2N5684, JAN, JANTX, AND JANTXV

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for PNP, silicon, power transistors. Three levels of product assurance are provided for each device type as specified in MIL-PRF19500.

1.2 Physical dimensions. See figure 1 (similar to TO-3).

1.3 Maximum ratings.

Types	P_T 1/		V_{CBO}	V_{CEO}	V_{EBO}	I_B	I_C	T_J and T_{STG}	$R_{\theta JC}$
	$T_C = +25°C$	$T_C = +100°C$							
	W	W	V dc	V dc	V dc	A dc	A dc	°C	°C/W
2N5683	300	171	60	60	5	15	50	-65 to +200	.584
2N5684	300	171	80	80	5	15	50	-65 to +200	.584

1/ Between $T_C = +25°C$ and $T_C = +200°C$, linear derating factor (average) = 1.715 W/°C.

AMSC N/A   FSC 5961
DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

1.4 Primary electrical characteristics.

Types	h_{FE2} 1/		h_{FE3} 1/		C_{obo}		h_{fe}		$V_{BE(sat)}$ 1/	
	$V_{CE} = 2$ V dc $I_C = 25$ A dc		$V_{CE} = 5$ V dc $I_C = 50$ A dc		$V_{CB} = 10$ V dc $I_E = 0$ 0.1 MHz $\leq$ f $\leq$ 1 MHz		$V_{CE} = 5$ V dc $I_C = 10$ A dc f = 1 kHz		$I_C = 25$ A dc $I_B = 2.5$ A dc	
	Min	Max	Min	Max	Min pF	Max pF	Min	Max	Min V dc	Max V dc
2N5683	15	60				2,000	15			2.0
2N5684	15	60	5			2,000	15			2.0

Types	$V_{CE(sat)1}$		$V_{CE(sat)2}$		Switching			
					t_{on}		t_{off}	
	$I_C = 25$ A dc $I_B = 2.5$ A dc 1/		$I_C = 50$ A dc $I_B = 10$ A dc 1/		(see table I and figures 2 and 3 herein)			
	Min	Max	Min	Max	Min μs	Max μs	Min μs	Max μs
2N5683		1.0		5.0		1.5		3.0
2N5684		1.0		5.0		1.5		3.0

1/ Pulsed (see 4.5.1).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.
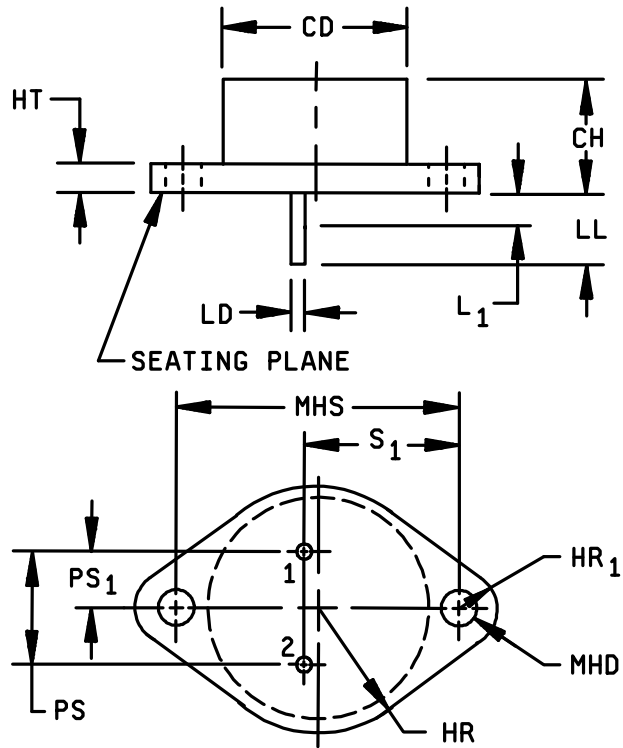
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FIGURE 1. Physical dimensions.

Ltr	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD		.875		22.33	
CH	.250	.328	6.35	8.33	
HR	.495	.525	12.57	13.34	
HR_1	.131	.188	3.33	4.78	
HT	.060	.135	1.78	3.43	
LD	.057	.063	1.45	1.60	4,5
LL	.312	.500	7.92	12.70	4,5
L_1		.050		1.27	4,5
MHD	.151	.161	3.84	4.09	
MHS	1.177	1.197	29.90	30.40	
PS	.420	.440	10.67	11.18	3
PS_1	.205	.225	5.21	5.72	3
s_1	.655	.675	16.64	17.15	3

NOTES:
1. Dimensions are in inches. Terminal 1 is base, terminal 2 is emitter, and case is collector.
2. Metric equivalents are given for general information only.
3. Measured at points .050 inch (1.27 mm) + .005 inch (0.13 mm) - .000 inch (0.00 mm) below the seating plane. When gauge is not used, measurement will be made at the seating plane.
4. Two places.
5. LD applies between L_1 and LL. Diameter is uncontrolled in L_1.
6. Collector shall be electrically connected to the case.
7. In accordance with ANSI Y14.5M, diameters are equivalent to ϕx symbology.

FIGURE 1. Physical dimensions – Continued.

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2.2 Government documents.

2.2.1 Specifications, standards and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service, 700 Robbins Avenue, Building 4D (DPM-DODSSP), Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specification and Standards (DODISS) and supplement thereto, cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DIDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Y14.5M - Dimensioning and Tolerancing. (Dod adopted)

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018-3308.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Associated specification. The individual item requirements shall be in accordance with MIL-PRF-19500, and as specified herein.

3.2 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.3 Interface requirements and physical dimensions. The Interface requirements and physical dimensions shall be as specified in MIL-PRF-19500, and figure 1, (similar to TO-3) herein.

3.3.1 <u>Lead finish</u>. Lead finish shall be solderable in accordance with MIL-PRF-19500, MIL-STD-750. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4 <u>Marking</u>. Marking shall be in accordance with MIL-PRF-19500.

3.5 <u>Electrical performance characteristics</u>. Unless otherwise specified herein, the electrical performance characteristics are as specified in paragraph 1.3, 1.4, and table I.

3.6 <u>Electrical test requirements</u>. The electrical test requirements shall be the subgroups specified in table I herein.

3.7 <u>Qualification</u>. Devices furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified manufacturers list before contract award (see 4.2 and 6.4).

4. VERIFICATION

4.1 <u>Classification of Inspections</u>. The inspection requirements specified herein are classified as follows:

    a. Qualification inspection (see 4.2).

    b. Screening (see 4.3)

    c. Conformance inspection (see 4.4).

4.2 <u>Qualification inspection</u>. Qualification inspection shall be in accordance with MIL-PRF-19500.

4.3 <u>Screening (JANTX and JANTXV levels)</u>. Screening shall be in accordance with table IV of MIL-PRF19500, and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table IV of MIL-PRF-19500)	Measurement
	JANTX and JANTXV levels
11	I_{CEX1} and h_{FE2}
12	See 4.3.1
13	Subgroup 2 of table I herein; $\Delta I_{CEX1} = \pm 100$ percent of initial value or 1.0 μA dc, whichever is greater. $\Delta h_{FE} = \pm 25$ percent of initial value

4.3.1 <u>Power burn-in conditions</u>. Power burn-in conditions are as follows:

    Adjust P_T to achieve $T_J = +187.5°C \pm 12.5°C$, $V_{CB} = \geq 10$ V dc

4.4 <u>Conformance inspection</u>. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 <u>Group A inspection</u>. Group A inspection shall be conducted in accordance with MIL-PRF-19500, and table I herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and paragraphs 4.4.2.1 herein. Electrical measurements (end-points) shall be in accordance with the applicable inspections of table I, group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

4.4.2.1 Group B inspection, table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500.

Subgroup	Method	Condition
B3	1037	For solder die attach, V_{CB} = $\geq$ 10 V dc, 2,000 cycles. No heat sink shall be permitted.
B3	1026	For eutectic die attach adjust P_T to achieve 175°C minimum. $V_{CB} \geq$ 10 V dc, $T_A \leq$ 35°C

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table VII of MIL-PRF-19500, and as follows. Electrical measurements (end-points) shall be in accordance with table I, group A, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

4.4.3.1 Group C inspection, table VII of MIL-PRF-19500.

Subgroup	Method	Condition
C2	2036	Tension: Test condition A weight = 10 pounds, t = 15 seconds
C6	1026	For eutectic die attach adjust P_T to achieve 175°C minimum. $V_{CB} \geq$ 10 V dc, $T_A \leq$ 35°C
C6	1037	For solder die attach, $V_{CB} \geq$ 10 V dc, 6,000 cycles. No heat sink shall be permitted. $T_A \leq$ 35°C

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical examination	2071					
Subgroup 2						
Collector to emitter breakdown voltage	3011	Bias condition D; I_C = 200 mA dc, pulsed (see 4.5.1)	$V_{(BR)CEO}$			
2N5683				60		V dc
2N5684				80		V dc
Collector to emitter cutoff current	3041	Bias condition D,	I_{CEO}		5.0	μA dc
2N5683		V_{CE} = 30 V dc				
2N5684		V_{CE} = 40 V dc				
Emitter to base cutoff current	3061	Bias condition D, V_{EB} = 5 V dc, I_C = 0	I_{EBO}		5.0	μA dc
Collector to emitter cutoff current	3041	Bias condition A, V_{BE} = 1.5 V dc,	I_{CEX1}		5.0	μA dc
2N5683		V_{CE} = 60 V dc				
2N5684		V_{CE} = 80 V dc				
Collector to base cutoff current	3036	Bias condition D,	I_{CBO}		5.0	μA dc
2N5683		V_{CE} = 60 V dc				
2N5684		V_{CE} = 80 V dc				
Base to emitter saturated voltage	3066	Test condition A, I_C = 25 A dc, I_B = 2.5 A dc, pulsed (see 4.5.1)	$V_{BE(sat)}$		2.0	V dc
Base to emitter saturated voltage	3066	Test condition B, V_{CE} = 2 V dc, I_C = 25 A dc, pulsed (see 4.5.1)	V_{BE}		2.0	V dc
Collector to emitter saturated voltage	3071	I_C = 25 A dc, I_B = 2.5 A dc, pulsed (see 4.5.1)	$V_{CE(sat)1}$		1.0	V dc
Collector to emitter saturated voltage	3071	I_C = 50 A dc, I_B = 10 A dc, pulsed (see 4.5.1)	$V_{CE(sat)2}$			
2N5683					5.0	V dc
2N5684					5.0	V dc

See footnote at end of table.

TABLE I. Group A inspection – Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 2 - Continued						
Forward-current transfer ratio	3076	V_{CE} = 2 V dc, I_C = 5 A dc, pulsed (see 4.5.1)	h_{FE1}	30		
Forward-current transfer ratio	3076	V_{CE} = 2 V dc, I_C = 25 A dc, pulsed (see 4.5.1)	h_{FE2}	15	60	
Forward - current transfer ratio	3076	V_{CE} = 5 V dc, I_C = 50 A dc, pulsed (see 4.5.1)	h_{FE3}	5		
Subgroup 3						
High-temperature operation		T_A = +150°C				
Collector – emitter cutoff current 2N5683 2N5684	3041	Bias condition A, V_{BE} = 1.5 V dc V_{CE} = 60 V dc V_{CE} = 80 V dc	I_{CEX2}		50	μA dc
Low-temperature operation		T_A = -55°C				
Forward – current transfer ratio	3076	V_{CE} = 2.0 V dc, I_C = 25 A dc, pulsed (see 4.5.1)	h_{FE4}	7		
Subgroup 4						
Pulse response:	3251	Test condition A except test circuit and pulse requirements per figures 2 and 3 herein.				
Turn – on time		V_{CC} = 30 V dc, I_C = 25 A dc, I_{B1} = 2.5 A dc	t_{on}		1.5	μs
Turn – off time		V_{CC} = 30 V dc, I_C = 25 A dc, I_{B1} = I_{B2} = 2.5 A dc	t_{off}		3.0	μs
Storage time		V_{CC} = 30 V dc, I_C = 25 A dc, I_{B1} = I_{B2} = 2.5 A dc	t_s		2.0	μs

See footnote at end of table.

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TABLE I. <u>Group A inspection</u> – Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 4</u> - Continued						
Magnitude of common emitter small-signal short-circuit forward-current transfer ratio	3306	V_{CE} = 10 V dc, I_C = 5 A dc, f = 1 MHz	$\lvert h_{fe} \rvert$	2.0	20	
Small – signal short circuit forward-current transfer ratio	3206	V_{CE} = 5 V dc, I_C = 10 A dc, f = 1 MHz	h_{fe}	15		
Output capacitance (open circuit)	3236	V_{CB} = 10 V dc, I_E = 0, 0.1 MHz $\leq$ f $\leq$ 1.0 MHz	C_{obo}		2,000	pF
<u>Subgroup 5</u>						
Safe operating area (dc operation)	3051	T_C = +25°C t = 1 s, 1 cycle, (see figures 4 and 5)				
<u>Test 1</u> (Both device types)		V_{CE} = 6 V dc I_C = 50 A dc				
<u>Test 2</u> (Both device types)		V_{CE} = 30 V dc I_C = 10 A dc				
<u>Test 3</u> 2N5683		V_{CE} = 50 V dc I_C = 560 mA dc				
2N5684		V_{CE} = 60 V dc I_C = 640 mA dc				
Safe operating area (switching)	3053	Load condition C, (unclamped inductive load) see figure 6, T_C = 25°C duty cycle $\leq$ 10 percent, R_S = 0.1 Ω, t_r = t_f $\leq$ 500 ns				
<u>Test 1</u>		tp = 5 ms, (vary to obtain I_C), R_{BB1} = 10 Ω, V_{BB1} = 20 V dc, R_{BB2} = ∞, V_{BB2} = 0, V_{CC} = 50 V dc, I_C = 20 A dc, L = 1 mH 2/				

See footnote at end of table.

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TABLE I. Group A inspection – Continued.

Inspection 1/	MIL-STD-750		Symbol	Limit		Unit
	Method	Conditions		Min	Max	
Subgroup 5 - Continued Test 2		t_p = 5 ms, (vary to obtain I_C), R_{BB1} = 100 Ω, V_{BB1} = 10 V dc, R_{BB2} = ∞, V_{BB2} = 0, V_{CC} = 50 V dc, I_C = 1.5A dc, L = 80 mH 3/				
Safe operating area (switching)		Clamped inductive load, T_A = 25°C V_{CC} = 50 V dc, (see figure 7 and 8)				
2N5683		Clamp voltage = 60 V dc				
2N5684		Clamped voltage = 80 V dc				
Electrical measurements		Group A, subgroup 2 herein				
Subgroups 6 and 7 Not applicable						

1/ For sampling plan, see MIL-PRF-19500.

2/ L = 1 mH Sanford Miller CK-50, 50A, .002 Ω, or equivalent.

3/ L = 80 mH (2 each Signal Transformer CH-6, 6A) 0.4 Ω, or equivalent.

TABLE II. Groups A, B and C delta measurements.

Step	Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward-current transfer ratio	3076	V_{CE} = 2 V dc; I_C = 25 A dc; pulsed (see 4.5.1)	Δh_{FE2}	±25%		

The delta measurements for table VIb of MIL-PRF-19500 are as follows:

   a. Subgroups 3 and 6, see table II herein, step 1.

The delta measurements for table VII of MIL-PRF-19500 are as follows:

   a. Subgroup 6, see table II herein, step 1.

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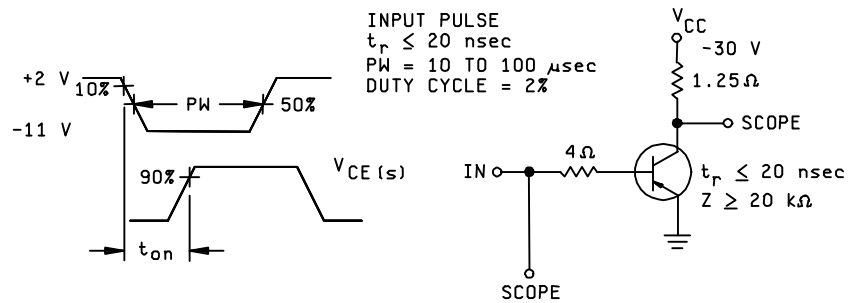
FIGURE 2. Turn-on (t$_{on}$) time test circuit.
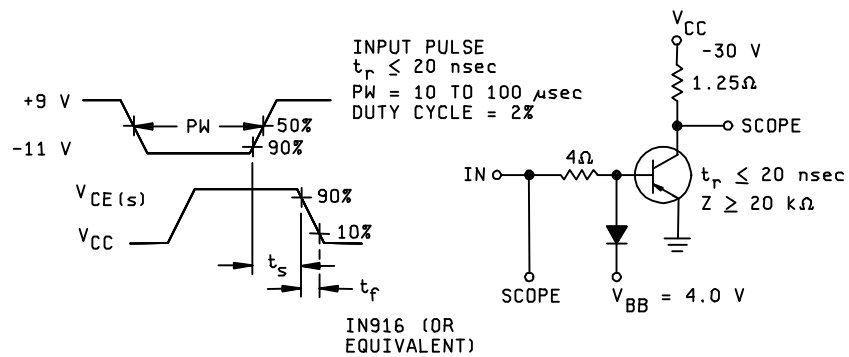
FIGURE 3. Turn-off (t$_{off}$) time test circuit.

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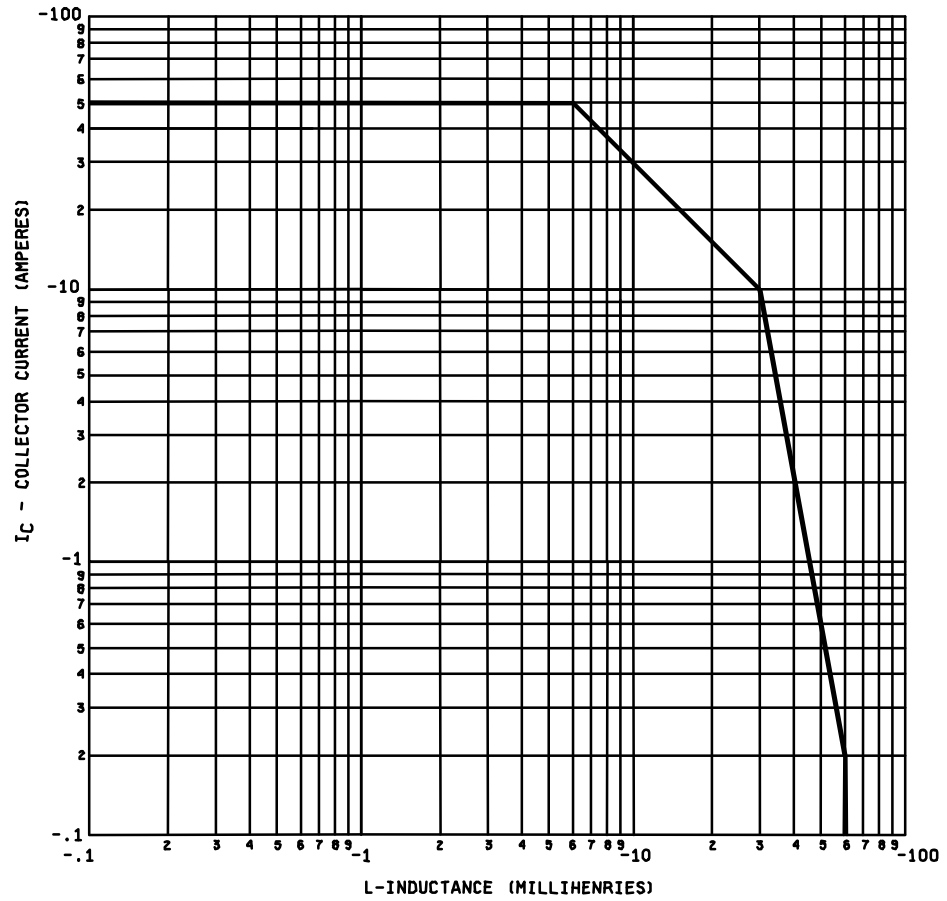
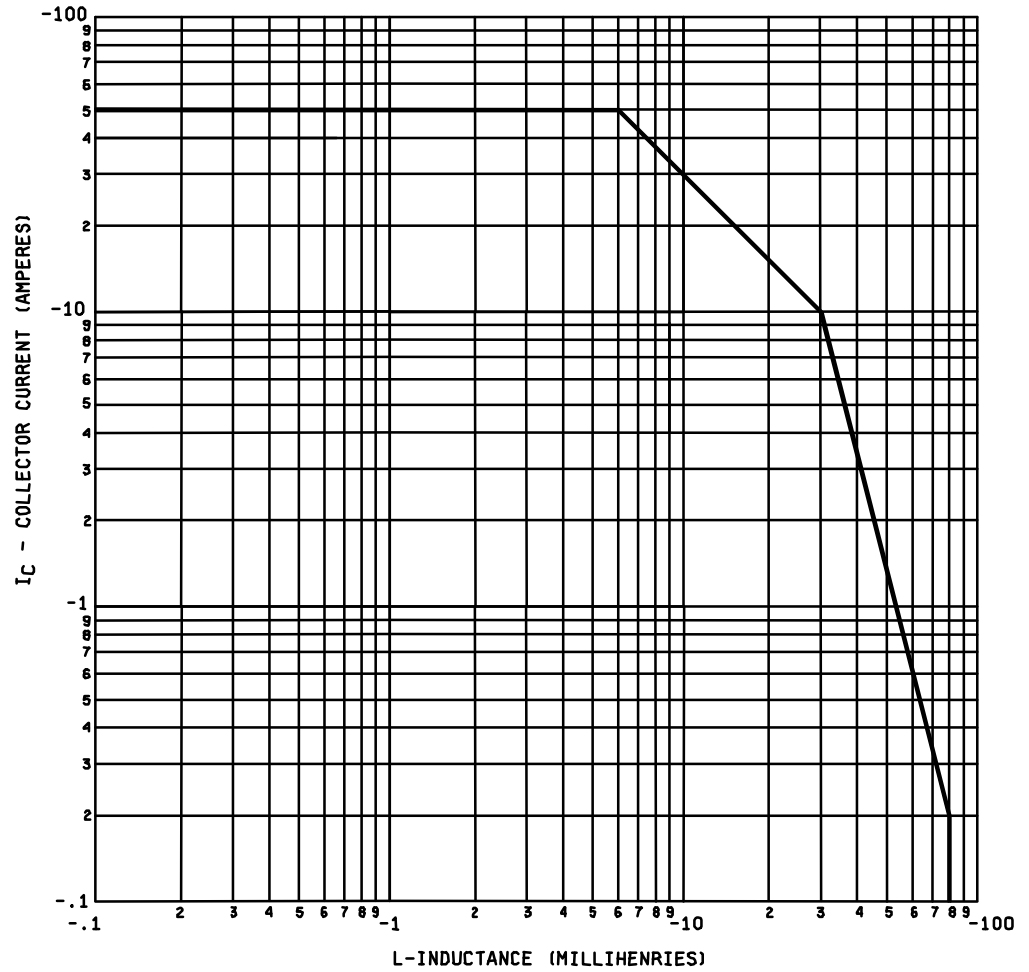FIGURE 4. Maximum safe operating area graph (continuous DC) for 2N5683.

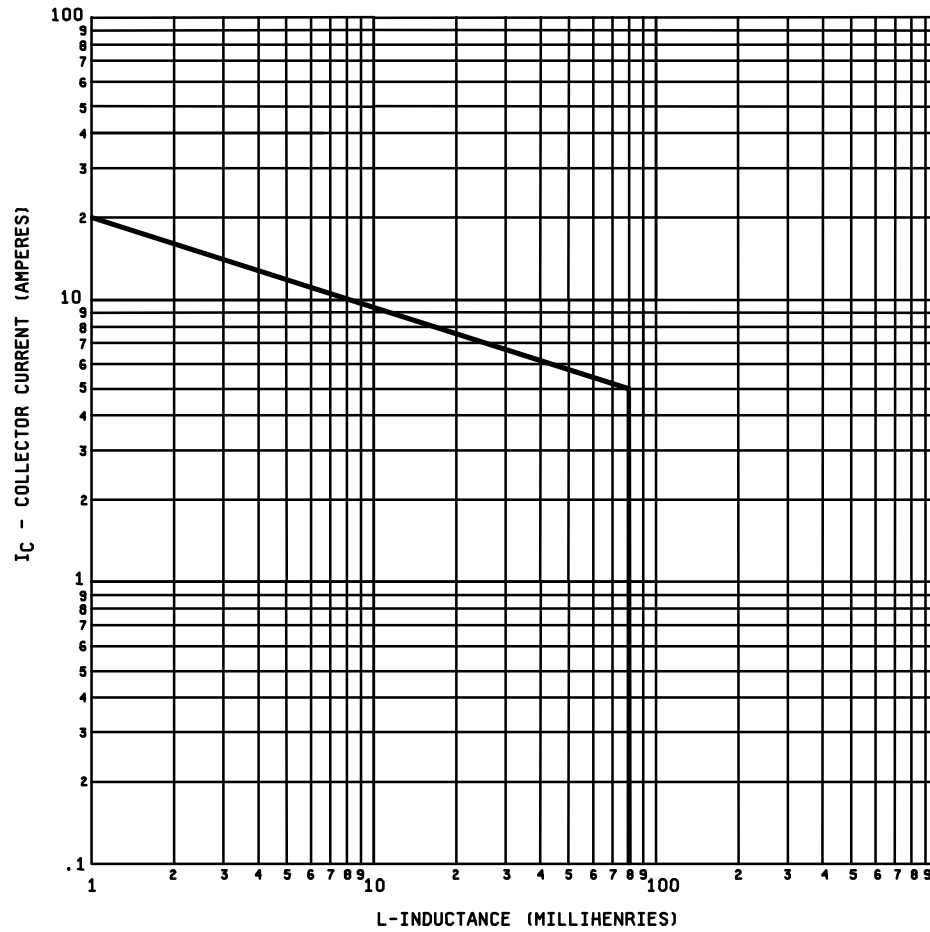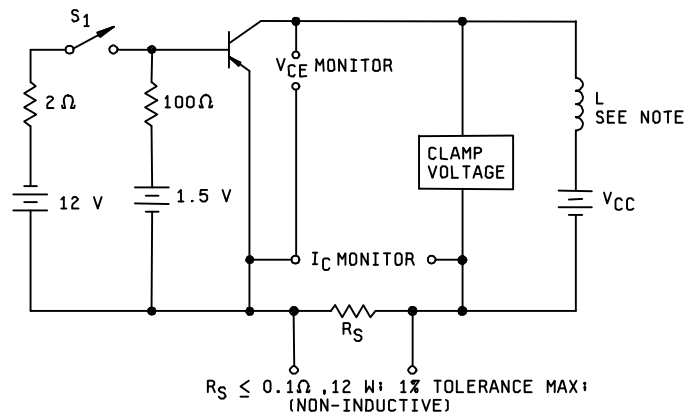FIGURE 5. <u>Maximum safe operating area graph (continuous DC) for 2N5684</u>.

FIGURE 6. <u>Safe operating area for switching between saturation and cutoff (unclamped inductive load)</u>.

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*L = 2.0 mH (2 each 1 mH
Sanford Miller CK-50, 50A)
R = .002 Ω

Procedure:
1. With switch S1 closed, set the specified test conditions.
2. Open S1. Device fails if clamp voltage is not reached.
3. Perform specified endpoint tests.

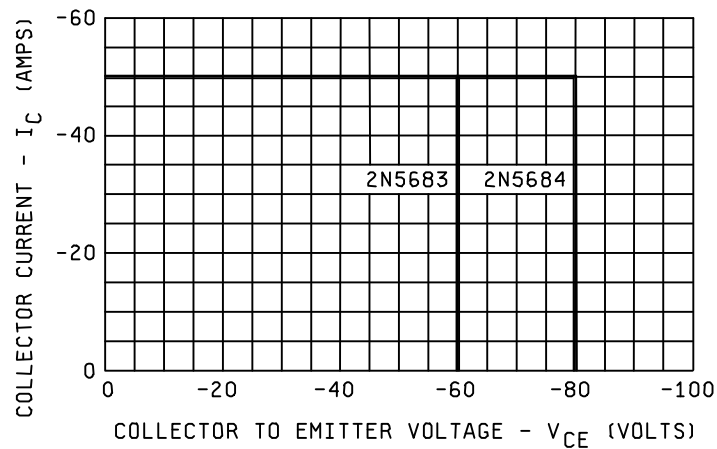FIGURE 7. Clamped inductive sweep test circuit.

FIGURE 8. Safe operating area for switching between saturation and cutoff (clamped inductive load).

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6. NOTES
(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Notes. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

   a.   Issue of DODISS to be cited in the solicitation and, if required, the specified issue of individual documents referenced (see 2.2.1).

   b.   Lead finish (see 3.3.1).

   c.   Type designation and product assurance level.

   d.   Packaging requirements (see 5.1).

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturer's List QML-19500 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center Columbus, DSCC-VQE, Columbus, OH 43216.

Custodians: Preparing activity:
   Air Force - 11   DLA - CC
   DLA - CC

Review activities: (Project 5961-F192)
   Air Force – 13, 19

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-PRF-19500/466B	2. DOCUMENT DATE *(YYYYMMDD)*

3. DOCUMENT TITLE

   SEMICONDUCTOR DEVICE, TRANSISTOR, PNP, SILICON, POWER, TYPES 2N5683, 2N5684, JAN, JANTX, AND JANTXV

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First Middle Initial)*	b. ORGANIZATION	

c. ADDRESS *(Include Zip Code)*	d. TELEPHONE *(Include Area Code)*
	(1) Commercial
	(2) DSN
	    (If applicable)
		7. DATE SUBMITTED
		    (YYYYMMDD)

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	   Defense Standardization Program Office (DLSC-LM)
	    8725 John J. Kingman Road, Suite 2533
	    Fort Belvoir, Virginia 22060-6221
	    Telephone (703)767-6888 DSN 427-6888

DD Form 1426, FEB 1999 (EG)   PREVIOUS EDITIONS ARE OBSOLETE.   WHS/DIOR, Feb 99